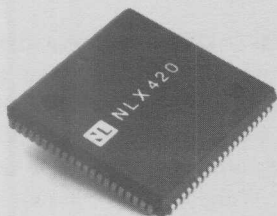




## Single-Chip Neural Network

### Neural Processor Slice™



It's your choice; choose the resolution you need - 1, 4, 8, or 16-bit, choose the transfer function - sigmoid, linear, step, pulse, or user designed, choose the architecture - feed forward, totally connected, feedback, single or multilayer.

NeuraLogix's NLX420 is a remarkably versatile neural processor that packs lots of power. A single device can operate at up to 320 Million connections/sec. The device's sixteen processing elements can expand to implement full networks. Multiple devices can be easily combined to provide even greater processing power.

The NLX420 is available today from the leader in artificial intelligence devices, NeuraLogix. To speed the transition from concept to completed design, an NPS Development System is available for your IBM® AT.

### Applications

- ☐ Autonomous Robotic Control
- ☐ Financial Forecasting
- ☐ Image Recognition
- ☐ Sensor Fusion
- ☐ Signal Classification

### Features

- ☐ 16 Independent Parallel Processors
- ☐ Over 300 Million Connections/Sec
- ☐ 16-Bit Weights, 32-Bit Accumulators
- ☐ Easy Expansion for Implementing Virtually Any Neural Network
- ☐ User Configurable Transfer Functions
- ☐ IBM® AT Development System
- ☐ Low Cost

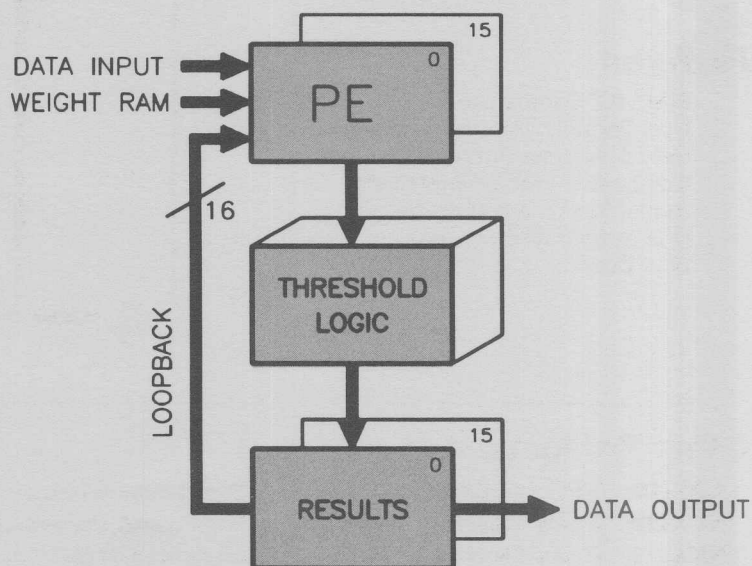
### Description

The Neural Processing Slice (NPS) is a high performance, easily expandable Neural Network building block. Included in the 84-pin PLCC are 16 independent processing elements (PE). Each PE is capable of emulating hundreds of neurons, with thousands of inputs, connected as multiple layers. Additionally, several NLX420 devices can be interconnected to increase performance even further.

An NLX420 can be configured to process variable length inputs and weights, from one to sixteen bits, while always utilizing full 32-bit internal accumulators. With the inputs and weights selected for 1-bit length, over 300 million connections per second can be achieved.

The NLX420 also contains completely user-configurable transfer functions. Basically any function that can be imagined can be implemented with full 16-bit accuracy.

The ADS420 offers expandability, performance and user configurable transfer functions, at an affordable price.



**NLX420 Block Diagram**

**American NeuraLogix, Inc.**



## Over 1 Billion Connections/Sec !

### NPS Development System

The Neural Processor Slice (NPS) Development System, ADS420, is a highly configurable Neural Network Development System. It is specially designed to operate in an IBM® AT environment by means of an add-in card and user friendly software. Neural Networks are easily configured, trained, and operated at real-time speeds.

An excellent tool for gaining experience in Neural Networks, the ADS420 also has a price/performance ratio that can not be matched.

Order one today, and put Neural Networks to work for you.

### Applications

- ☐ Training Tool for the NPS
- ☐ Neural Network Coprocessor
- ☐ Hardware Development Tool
- ☐ Real-Time Neural Networks

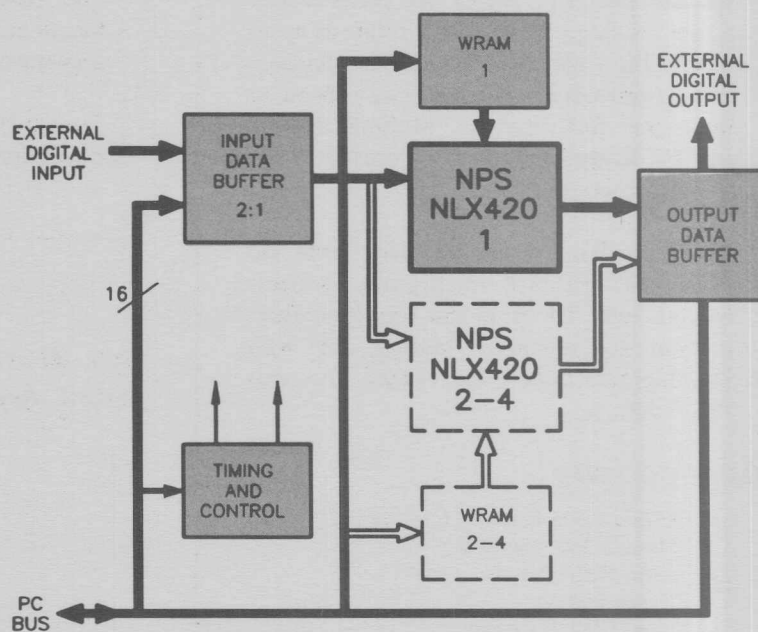
### Features

- ☐ IBM® AT Compatible
- ☐ User Friendly Menus and Windows
- ☐ User Selectable Architecture
- ☐ Compatible with *BrainMaker™*
- ☐ Digital Inputs and Outputs
- ☐ One or Four NPS Devices
- ☐ Low Cost

### Description

The NPS Development System (ADS420) is available with either one or four NPS devices, along with interface and control hardware, and on-board weight memories. User friendly Menu Driven software is provided, for complete control and training of Neural Networks. Access to external data sources is accomplished through a 50 pin connector. Weights can be down-loaded from external software simulators, such as *BrainMaker™* from California Scientific Software, or from the built in training paradigms.

An ADS420-1, for only \$595, contains one NPS device and can process over 300 Million Connections per second. The ADS420-4, with four NPS devices, processes over 1 Billion connections per second, and costs only \$1495.



ADS420 Block Diagram

### Other Products

- |        |                          |   |
|--------|--------------------------|---|
| ADS110 | FPC Applications System  | - Direct comparison of Video, analog or digital data in real-time         |
| NLX110 | Fuzzy Pattern Comparator | - High Speed 1M pattern comparator for real-time data and imaging systems |
| NLX112 | Fuzzy Data Correlator    | - High Speed 128-bit correlator with $\mu P$ interface                    |
| NLX113 | Fuzzy Data Correlator    | - Four 32-bit, two 64-bit, or one 128-bit (user configurable) correlators |
| ADS230 | FMC Development System   | - Full function development system for the NLX230 Fuzzy MicroController   |
| NLX230 | Fuzzy MicroController    | - High Speed Fuzzy Logic Controller                                       |

American NeuraLogix, Inc.



## Questions And Answers For The NLX420 Neural Processor Slice

### INTRODUCTION

The following questions and answers were prepared as a result of numerous inquiries from customers regarding NeuraLogix's NLX420 Neural Processor Slice. Detailed information is provided in the NLX420 Neural Processor Slice data sheet.

### QUESTIONS AND ANSWERS

#### Q. What is a Neural Processor Slice?

A. The NLX420 Neural Processor Slice (NPS) is a semiconductor device designed for implementing real-time neural network systems. Although a single NPS can be used as a system, the NLX420 has been designed to allow many devices to be tied together so that almost any neural network that can be imagined can be built. The NPS is not controlled by instructions as is a computer, instead it is controlled by distributed weights. Because of the highly parallel architecture in the NPS, a system built from NPS devices will be much faster than software "simulated" neural networks.

#### Q. What can the NPS be used for?

A. The NLX420 is best suited for real time applications such as:

- ☐ Image Classifiers
- ☐ Target Recognition
- ☐ Speech Recognizers
- ☐ Classification Problems such as Risk Analysis
- ☐ Signal Processing
- ☐ Robotics and Adaptive Control Problems
- ☐ Simulation

The NPS is not intended to replace existing computers but operating as a 'Neural Coprocessor', it can add real time intelligent functions to these machines.

#### Q. How is the NPS configured?

A. Configuration of the NPS is accomplished through both hardwired connections and connections set up through internal register control. This allows a typical system to be hardwired in a general configuration, and then modified through register control to adapt it to a particular problem. The internal register control, called the 'Programmable Interconnect', also reduces external 'glue' hardware and circuit board connections.

#### Q. What form of learning is incorporated in the NPS?

A. Because there is not a single paradigm that can be used for training a neural network for all applications, learning hardware has not been included in the NPS. Hardware and software hooks have been provided to permit easy access to the weights and other registers. In this way, a general purpose computer or microcontroller can implement the paradigm of choice.

#### Q. How many neurons does the NPS have?

A. An NPS device contains 16 processing elements. Each processing element can be configured to implement anywhere from 1 to 64K neurons.

#### Q. How many synapse inputs can each neuron have?

A. An NPS can be configured to have as many as 64K 16-bit synaptic inputs.

#### Q. What is the length of the synaptic weights?

A. The synaptic weights are selectable at one, four, eight or sixteen bits and are configured as two's complement numbers. Each processing element contains a 32-bit accumulator to enable construction of large networks.



**Q. Why are the weights stored externally?**

**A.** Because the NPS device can be configured in many different ways, the actual amount of storage required is application dependent. All of the hooks and control signals needed to interface to this external RAM are provided by the NPS.

**Q. What kinds of input data can the NPS accept?**

**A.** The NPS is a digital device and therefore its inputs and outputs accept only digital signals. Input data are parallel words from one to hundreds of bits long. For example input data could come from switches or other sensors, Analog to Digital Converters, or other NPS devices.

**Q. What is the output from an NPS?**

**A.** The output from an NPS Neuron could be the final 'Dot Product' or it could be internally compared to any user-selectable threshold function.

**Q. What language is used for programming the NPS?**

**A.** Since the NPS is not a conventional computer, it is not programmed in the conventional manner. Instead of being controlled by instructions, the NPS is controlled through distributed weights. A conventional computer, programmed with any language, could be used to assign these weights. Since the weights are easily memory mapped, prelearned values can quickly be saved or reloaded from disk files.

**Q. How fast is the NPS?**

**A.** The NPS can be operated with a 20MHz clock. At this rate it would require an 800MIPS computer, doing nothing else but NPS functions, to generate solutions as quickly as the NPS device. Actual neuron speed is dependent on the configuration of the NPS device as well as the clock rate. Using one bit weights, the NPS will perform over 300 million connections per second.

**Q. What computers can the NPS interface to?**

**A.** With a standard 8-bit bus interface, any computer, microprocessor, or controller could interface

with the NPS using minimal hardware.

**Q. Can't the NPS functions be performed with a general purpose microprocessor?**

**A.** Although the NPS functions could be performed by a general purpose microprocessor, it would not be as fast and would cost much more. Furthermore, the NPS is designed to allow easy expansion with other NPS devices without a decrease in speed and with little interface hardware.

**Q. How is the NPS device packaged?**

**A.** The NPS is packaged in a 84-pin PLCC. This industry standard package permits either surface mount or socket mount option.

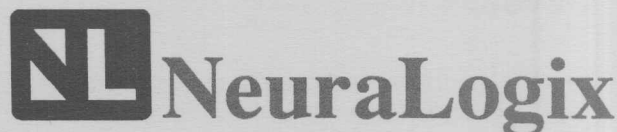
**Q. Must I understand Neural Networks to design a system around the NPS?**

**A.** Operation of the NPS device is so straight forward most hardware designers have little trouble designing with it. However, an understanding of basic neural network theory would certainly be useful. NeuraLogix has available data sheets and applications notes that should answer most questions.

**Q. What does the NLX420 Evaluation Kit do and what do I get with it?**

**A.** The NLX420 Evaluation kit comes with the literature listed above and an Eval kit users manual, a PC compatible fully assembled PWB, and user friendly software. It enables the user to easily construct virtually any Neural Network.

*If you have any questions concerning this or any of our many other fine products, please contact one of our applications engineers at the address or phone number shown below.*



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